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(54) Automatic tool exchanger.

(57) A simple and efficient tool exchanger device is presented. The device has a pair of swing arms (8, 9), and each swing arm is provided with a set of grippers (11, 12) for holding a tool bit. The positions of the swing arms (8, 9) are separated by 90 degree so that they will not interfere with each other during the swinging motion. One driving device (2) is provided to operate both swing arms (8, 9) and operate the gripper devices (11, 12). The swing arm (8) rotates upwards to remove a used tool bit (10) from the machining shaft (21) of a machining center and the other swing arm (9) is rotated downwards to install a new tool bit (10') in the vacated machining shaft in a single simultaneous step.

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Background of the Invention

Field of the Invention

The present invention relates to a device for automatically exchanging tools between a main machining axis and a tool magazine.

Technical Background

Productivity improvement is one of the basic requirements of a machining center. With an improvement in cutting efficiency being achieved in modern machining centers, there is a strong need for shortening the non-cutting time particularly for light alloy fabrication operations which generally require short cutting time. There is thus an important need for shortening the time required for exchanging the tools between machining steps, because such steps occupy almost 20 percent of the total machining cycle time. To date, various tool exchanger devices have been disclosed, for example, in referenced such as Japanese Utility Model, S61-42755 and JP, First Publication, S61-53182 and JP, First Publication, H5-16047.

Such a device typically performs the following steps: gripping a tool bit, a used bit which has completed its job, disposed in the machining shaft; removing the used tool bit from the tapered hole of the machining shaft; exchanging the position of the used tool bit disposed on a line of the extension of the machining shaft with another tool bit to be used in the same position; inserting the another tool bit in the machining shaft; and releasing the hold on the machining shaft so that the machining shaft can rotate and move into an operating position. However, such a device tries to improve the machining efficiency by speeding up the steps by using hydraulic or mechanical transmission systems.

The conventional device of this type suffered from the following problems.

(a) There is a large motion range (the path of travel made by the tool bits to be exchanged), and the improvement is limited basically by the acceleration achievable within the speed attained by the tool bit.

(b) For each motion of the steps, acceleration and deceleration periods are required, and a time lag is generated.

(c) Various mechanisms are required for performing the various steps, and the device becomes complex to make, thus increasing the chances of device breakdowns.

Summary of the Invention

The tool bit exchanger device of the present invention was made to resolve the problems outlined above, and the purpose is to present a device which can be manufactured easily and able to perform exchanging of tool bits automatically and reliably.

This purpose is achieved in a device comprising: a support frame; a rotating shaft having a swing arm having a gripper device freely rotatably disposed on the support frame; another rotating shaft having another swing arm having another gripper device freely rotatably disposed on the support frame; and a driving device for operating the swing arms so as to remove one tool bit from a machining shaft disposed on a machining center with one gripper device of the swing arm and simultaneously installing another tool bit with another gripper device of the another swing arm in a vacated the machining shaft disposed on the machining center.

A feature of the device is that an output shaft of the driving device has a bevel gear to engage with a follower bevel gear disposed on the rotating shaft and with another follower gear disposed on the another rotating shaft.

A feature of the device is that the one rotating shaft and the another rotating shaft is separated by a 90 degree separation angle.

A modification of the device of the present invention is that the driving device for operating the swing arms is provided individually on each of the one rotating shaft and the another rotating shaft.

The device presented above has a pair of rotation shafts each of which is provided with a swing arm having a set of gripper devices. The swing arms can be rotated freely without interfering with each other so that the tool bit used for machining disposed on the machining shaft of the machine center is removed by one set of grippers disposed on one swing arm and simultaneously the other set of grippers disposed on the other swing arm installed a new tool bit on the vacated machining shaft of the machining center.

The above presented action of the device is made possible by disposing a bevel gear on the output shaft of the driving device so as the drive the two rotation shaft by means of a follower bevel gear disposed on each of the rotation shafts. Such an arrangement of the driving mechanism produces simple and durable device which does not generate errors and breakdowns thus providing reliable machining operations.

A modification of the device is also presented such that the driving device is provided individually on each of the rotation shafts of the device of the present invention. The device of such a construction is advantages compared with the conventional devices for automatic changing of tool bits because the steps required in the conventional devices: removing the tool bit from the machining shaft; switching the used tool bit with a new tool bit; installing the new tool bit in the machining shaft of the machining center; are eliminated and replaced with one step of simultaneously removing the used tool bit from the machining shaft and

Installing the new tool bit and in the machining shaft of the machining center. Therefore, the entire operation of exchanging the tool bits is carried out efficiently to improve the machining operation of the machining center.

Brief Description of the Drawings

Figure 1 presents a fragmented front view of the main parts of an embodiment of the device of the present invention for automatically exchanging tool bits.

Figure 2 is a perspective view of the embodiment seen from the left towards the right in Figure 1.

Figure 3 is a perspective view of the embodiment seen from the right towards the left in Figure 1.

Figure 4 is a side view showing the positional relationship between the machining shaft and a pair of rotating arms.

Figure 5 is a schematic illustration of the device of the present invention installed on a machining center.

Figure 6 is a side view of the machining center shown in Figure 5.

Preferred Embodiment of the Invention

An embodiment of the present invention will be explained with reference to Figures 1 to 4. A tool exchanger device A in Figure 1 is a device for automatically exchanging tool bits, and comprises a support frame 1 and a driving mechanism 2 firmly fixed on the support frame 1 as well as the rotating shafts 3, 4 supported by the bearings la, lb. The driving mechanism 2 comprises electric and hydraulic motors, and associated actuators. A bevel gear 5 having a bearing lc is attached to the bottom end of an output shaft 2a by a fixing device 2b.

The pair of rotating shafts 3, 4 are disposed symmetrically on the left and right sides of the output shaft 2a, and the extension lines from the centers of the rotating shafts 3, 4 cross each other at the extension line of the center line of the output shaft 2a at the base of the output shaft 2a of the bevel gear 5. Above the upper end of the rotating shafts 3, 4, there are follower bevel gears 6, 7, which are supported by the fixing devices 3a, 4a and engaged with the bevel gear 5.

Swing arms 8, 9 having a 90 degree separation angle are fixed to the rotating shaft 3, 4 respectively by fixing devices 3b, 4b (4b is not shown). Each swing arm 8, 9 is respectively provided with a set of gripper device 11, 12 at its free end for grasping a tool bit 10. The swing arms 8, 9 with the gripper devices 11, 12 are disposed symmetrically, and are driven by the driving device 2. The motions of the swing arms 8, 9 are as follows: they rotate 90 degrees simultaneously within a plane about the machining shaft 21 of a machining center B; resulting in that one of the swing arm 8 removes the gripper devices 11 from the operating position (the position of the swing arm 8 in Figure 1) to a stand-by position (the position of the swing arm 9 in Figure 1) at the same time as the swing arm 9 moves the gripper device 12 from the stand-by position to the operating position. The designs of the gripper devices 11, 12 are known, as are the hooks 11a, 12a which elastically hold the tool bit 10.

The tool exchanger device A of the above configuration is disposed between a machining shaft 21 and a tool magazine 22 of a machining center B, as shown in Figures 5 and 6. The support frame 1 is attached to a guide rod 23, as shown in Figure 6, and in freely movable in the directions of X- and Y-axis. The machining shaft 21 is freely movable in the Z-axis direction. The X-axis direction is left/right, the Y-axis direction is up/down and the Z-axis direction is at right angles to the plane of the paper in Figure 5.

The tool magazine 22 shown in Figure 6 comprises an endless chain 24 having a plurality of links provided with tool holder (not shown), driven by pulleys 25, 26 and 27. The tool magazine 22 rotates the new tool bit 10', held in the tool bit holder with the tool bit lying in the X-axis direction. The tool magazine 22 also rotates the tool pots, which serve as the shell for the shank part of tool bit 10', 90 degrees in the horizontal direction so as to orient the tool bit axis in the Z-axis direction at the pulley 25. This is shown at D in Figure 5. The machining center B is a known conventional type.

The operation of the exchanger device A of the present invention will be explained in the following.

A tool bit 10 (new or used) is installed on the gripper devices 11 of the swing arm 8 or the gripper device 12 of the swing arms 9 by the following steps. Referring to Figure 5, the device A is moved in the X-axis direction from the stand-by position relative to the machining shaft 21 or the tool magazine 22. Either the gripper devices 11 of the swing arm 8 or the gripper device 12 of the swing arm 9 is disposed directly above the machining shaft 21 which has been moved to the first exchange position C, or directly above the second exchange position D of the tool bit 10 taken out of the tool magazine 22 and disposed so that its shaft lies parallel to the machining shaft 21. The device A is then lowered relative to the machining shaft 21 or to the tool bit 10 of the tool magazine 22. The tool bit 10 of the tool magazine 22 held in the gripper devices 11,12 is oriented in the Z-axis direction by the rotation of the holding device of the endless chain 24.

When the tool bit 10 (new or used) is to be removed from the gripper devices 11, 12, the device A is raised vertically relative to the machining shaft 21 when the tool bits 10 held in the gripper devices 11, 12 are attached to the machining shaft 21 or to the tool magazine 22.

When the tool bit 10 (new or used) is to be ex-

changed between the machining shaft 21 and the tool magazine 22, a used tool bit 10 is first held in one grip 12 of the grippers devices 11, 12, for example, of the swing arm 9 folded to the bottom side, and then the driving device 2 is operated. The operation of the driving device 2 makes the swing arm 9, having the used tool bit 10 in its gripper device 12, swing upwards, thereby removing the used tool bit 10 from the tool magazine 22 and assumes a horizontal position. The swing arm 8, having an empty gripper device 11, rotates downward at the same time as the swing arm 9 rotates upwards.

Next, the device A is first raised upwards, and then the device A is moved in the X-axis direction to dispose the empty gripper device 11 of the swing arm 8 to a location above the machining shaft 21. The device A is then lowered to grip the used tool bit 10 disposed in the machining shaft 21 in the gripper device 11. This condition is illustrated in Figure 1.

The driving device 2 is now driven in the reverse direction to the above preparatory step. By this action, the swing arm 8 is rotated upwards, thereby removing the used tool bit 10 from the machining shaft 21 and assumes a horizontal position. At the same time the other swing arm 9 rotates downward as the swing arm 8 is moving upwards, and installs a new tool bit 10' in the now vacated machining shaft 21. After this step, the device A is raised upwards away from the machining shaft 21 to remove the gripper device 11 from the new tool bit 10'. The machining center B is now ready to perform a machining operation using the new tool bit 10'. By following the similar steps, the used tool bit 10 disposed on the swing arm 8 is returned to the tool magazine 22, thereby completing the exchange operation.

In the above descriptions, it is understood that the sequence of operations taken by the machining shaft 21 and the tool magazine 22 are general in nature, and other sequences are possible depending on the type of tool magazine and other details of the equipment. In the embodiment illustrated, each tool bit is identified by the chain numbers of the tool magazine, and tool bit management is facilitated. The tool pots are random with respect to the tool bits and the chain, and this arrangement is useful in shortening the preparation time for readying the next tool bit.

The above embodiment is a case of driving two swing arms 8, 9 at the same speed with one driving device 2, and mechanical interference between the two swing arms 8, 9 is avoided by positioning them suitably. It is also possible to avoid interferences by delaying the starting times for one swing arm relative to the other swing arm, by altering the speeds of the swing arms. Therefore, it is possible to avoid mechanical interferences by using the positional elements as well as chronological elements. However, as long as even a part of the operation of the swing arms 8, 9 is duplicated, such duplication times can be shortened, therefore, the meaning of simultaneous rotation, or rotating at the same time, includes the cases in which the rotations of the swing arms 8, 9 partly overlap each other.

It is also possible to use two driving devices 2 to drive the swing arms 8, 9 individually. In changing the rotation initiation times or rotation speeds, arrangements other than the bevel gear arrangement may be used, but the control operation is easier with two driving devices.

Claims

1. A device for exchanging tool bits automatically comprising:

   a support frame (1)

   a rotating shaft (3), having a swing arm (8) having a gripper device, freely rotatably disposed on said support frame (1);

   another rotating shaft (4) having another swing arm (9), having another gripper device (12), freely rotatably disposed on said support frame (1); and

   a driving device (2) for operating said swing arms so as to remove one tool bit from a machining shaft (21) disposed on a machining center (B) with one gripper device (11) of said swing arm (8) and simultaneously installing another tool bit with another gripper device (12) of said another swing arm (9) in a vacated said machining shaft (21) disposed on said machining center (B).

2. A device as claimed in claim 1, wherein an output shaft of (2a) said driving device has a bevel gear (5) to engage with a follower bevel gear disposed on said rotating shaft (3) and with another follower gear disposed on said another rotating shaft (4).

3. A device as claimed in claim 1, wherein said one swing arm (8) and another swing arm (9) are disposed with a 90 degrees separation angle.

4. A device as claimed in claim 1, wherein said driving device (2) for operating said swing arms is provided individually on each of said one rotating shaft (3) and said another rotating shaft (4).

FIG.1

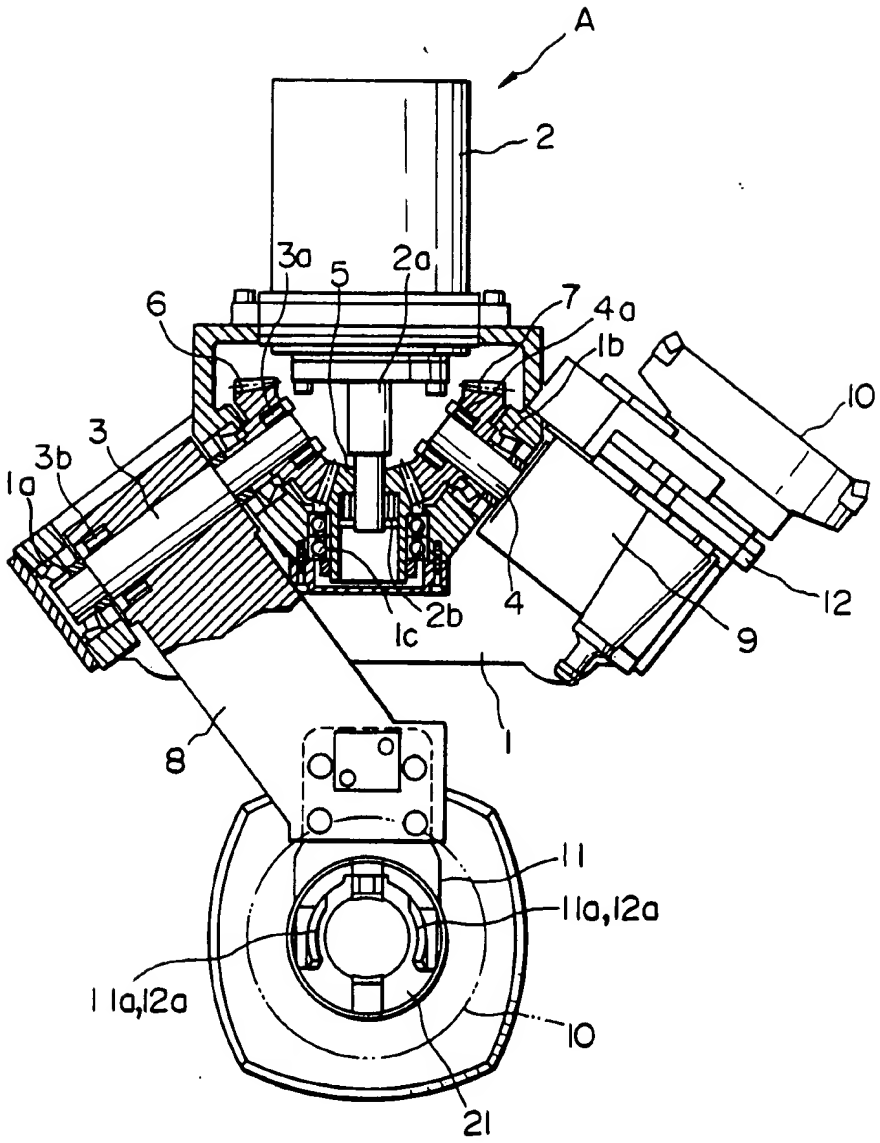

FIG.2

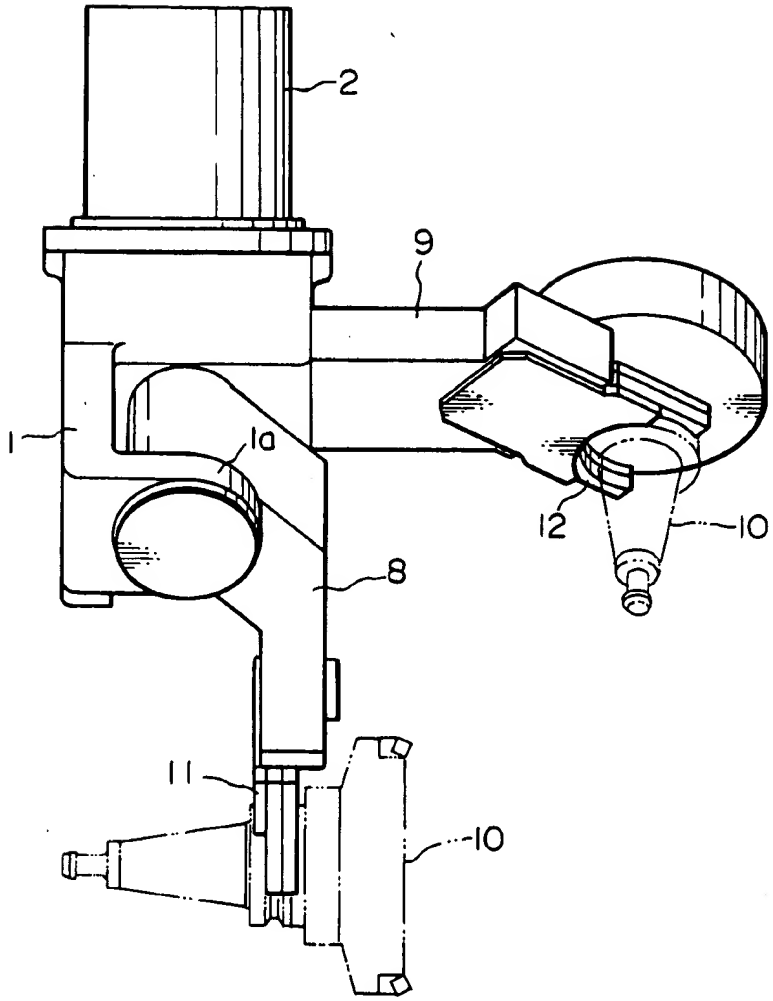

FIG.3

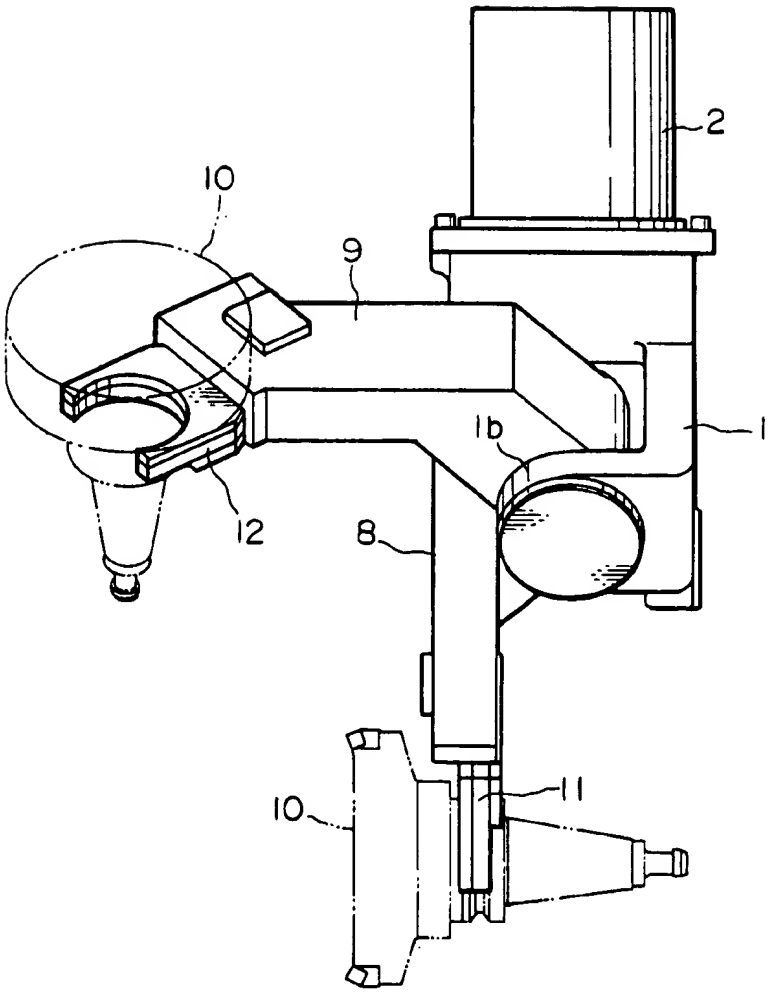

FIG.4

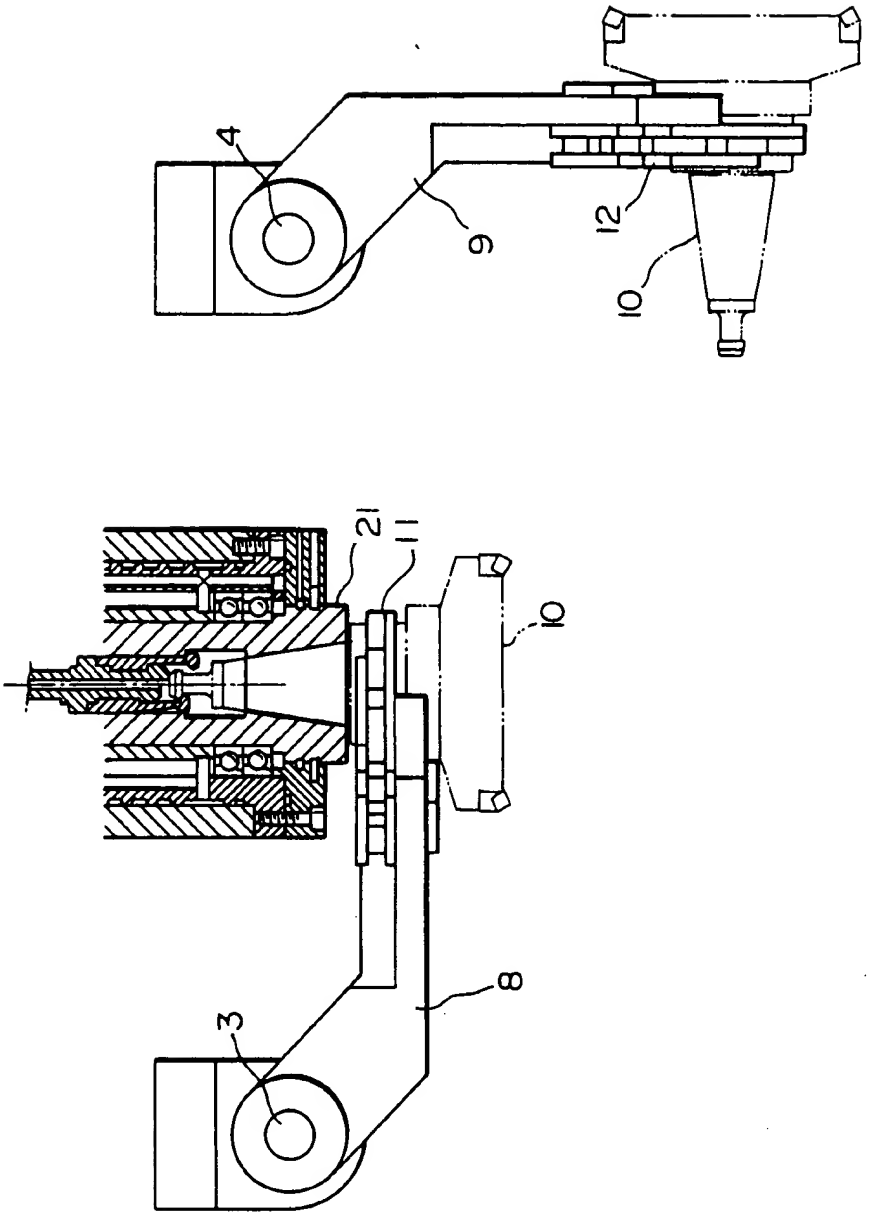

FIG.5

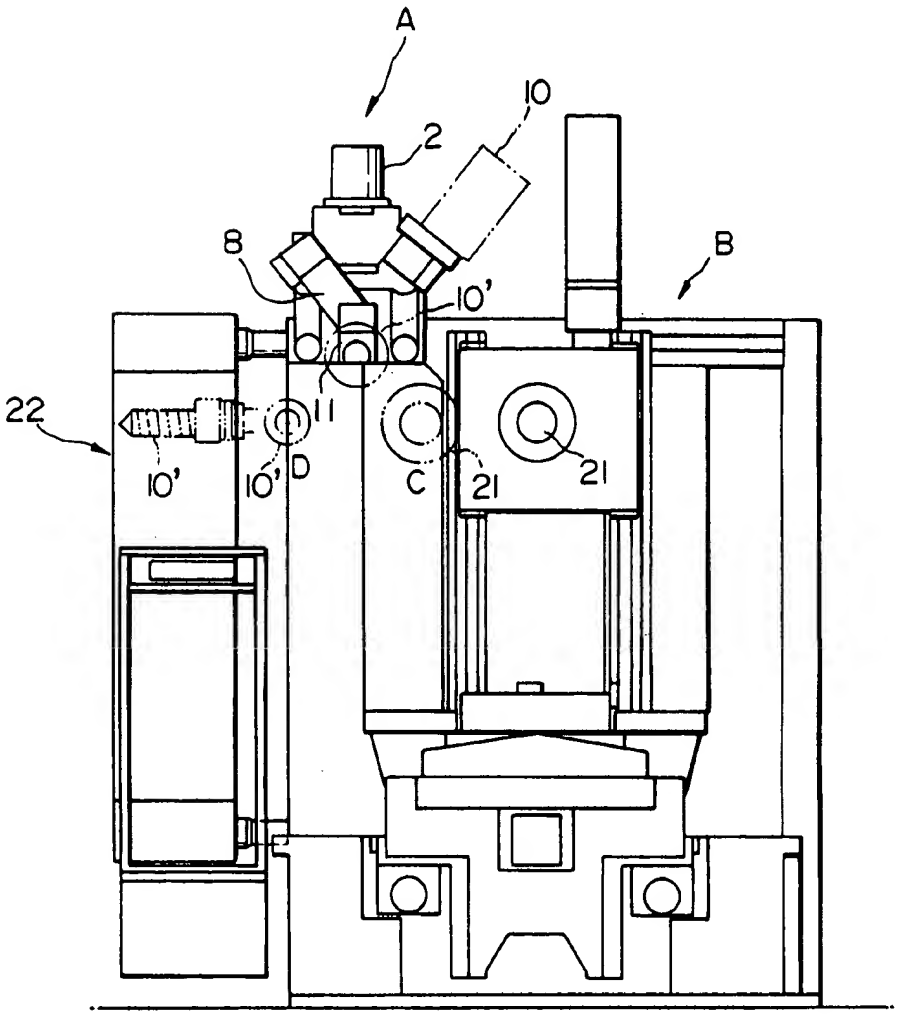

FIG.6